Magnetic Fields Emerging through the Solar Convection Zone

Science Mission Directorate

The behavior of magnetic fields near the solar surface is the ultimate driver of Earth's space weather. The goal of this project is to understand the magnetodynamics of the solar surface and upper convection zone in both quiet and active regions of the Sun.

Realistic numerical simulations of solar surface magnetoconvection are needed to model the atmospheric and subsurface behavior of the Sun, interpret observational data, and test and validate observational analysis and inversion procedures.

We compare observables calculated from the simulations with observations from the Swedish 1-m Solar Telescope, the Global Oscillation Network Group (GONG), Hinode, the Solar Dynamics Observatory (SDO) and, later, the Advanced Technology Solar Telescope (ATST), to verify both the simulation results and observational analysis procedures.

Massively parallel supercomputers are essential for running these calculations, which require long time-series on very large grids. These calculations were performed using up to 2,016 cores on NASA's Pleiades supercomputer. Visualization experts at the NASA Advanced Supercomputing (NAS) facility provided a concurrent visualization capability for use with the simulations.

As model building is an integral part of scientific understanding, we are also constructing an exhibit on how scientists use models, in collaboration with the Impression 5 Science Museum in Lansing, Michigan, under a NASA Education and Public Outreach grant. The exhibit will incorporate this work as one of its examples.

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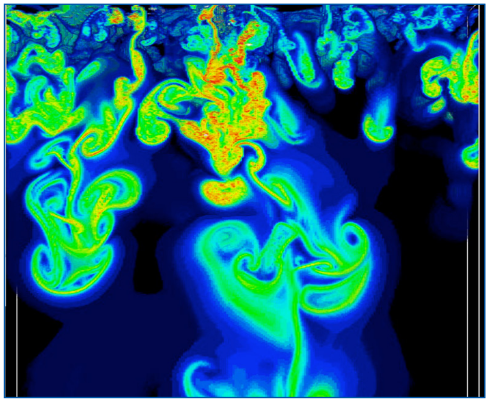

The solar convection zone is very turbulent. This image shows vorticity visualized by the Finite Time Lyapunov Exponent Field for a time interval of 11.75 hours, in a subdomain 21 megameters (Mm) wide x 19 Mm high x 0.5 Mm thick, from a 48-by-48 Mm wide by 20 Mm deep simulation. *Bryan Green, NASA/Ames; Robert Stein, Michigan State University*